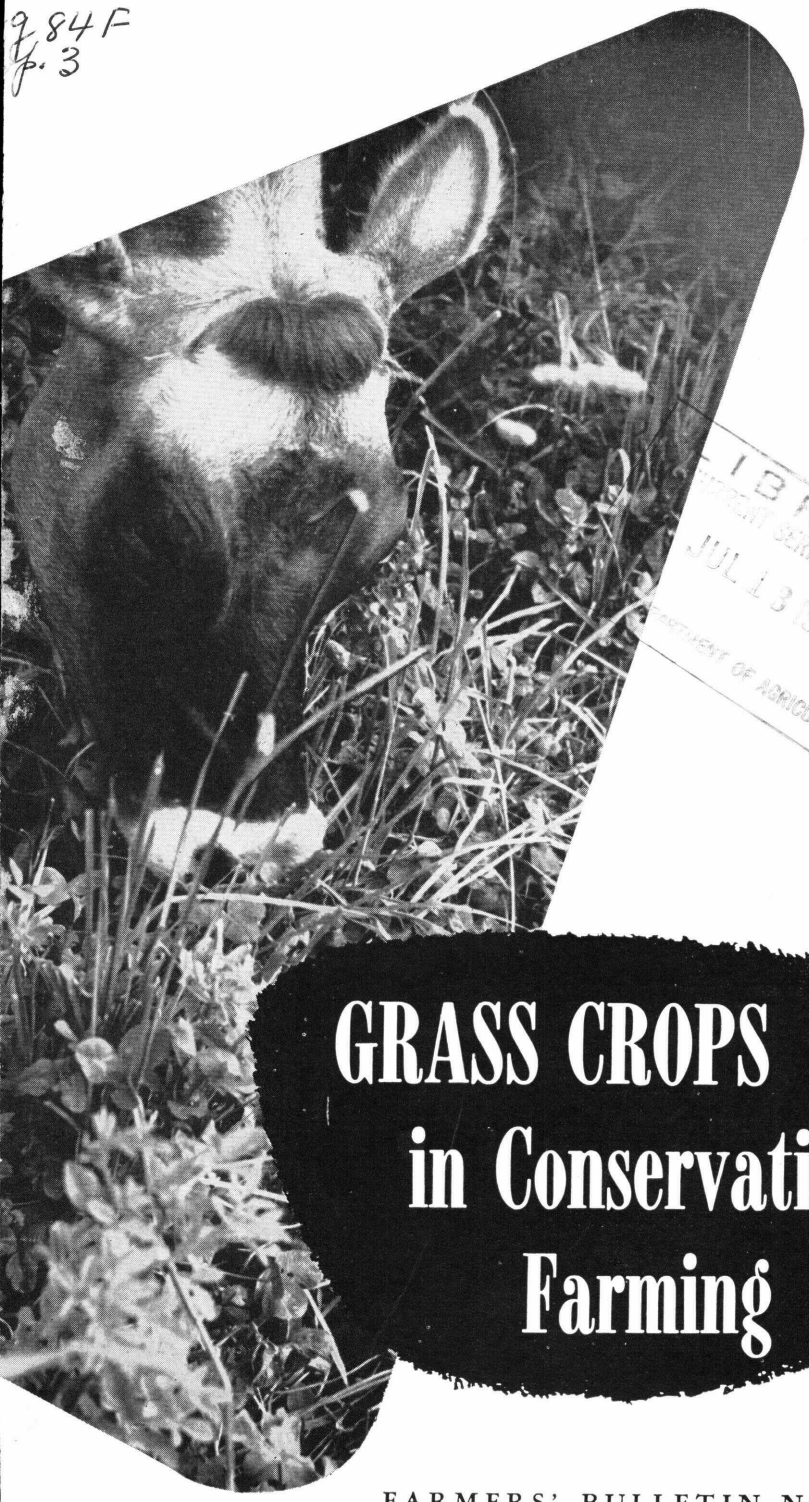

GRASS CROPS in Conservation Farming

FARMERS' BULLETIN NO. 2080
UNITED STATES DEPARTMENT OF AGRICULTURE

Grass Means Better Conservation

The growing of more and better grass crops means better conservation of the Nation's basic soil and water resources.

Experiment stations, agricultural technicians, and many farmers and ranchers have demonstrated time and again that most of our grassland could produce from 2 to 4 times as much as it now does. They have shown that grassland improvement offers the greatest potential for increasing agricultural production in this Nation. Furthermore, they have shown that through better use and care of grass crops we can sustain a permanent agriculture and at the same time produce at a high rate.

CONTENTS

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GRASS CROPS in Conservation Farming

By Tom Dale, *information specialist,* and Grover F. Brown, *chief agronomist, Soil Conservation Service*

Grass crops—grasses, legumes, or mixtures of the two—have been receiving more and more attention in the United States. The grassland boom has been gaining momentum since the 1930's. Soil conservation has contributed a lot toward it, but more is involved than soil conservation. Farmers and ranchers are rapidly coming to think of grasses and legumes as among their most important crops.

Grass crops are still not getting the attention they deserve, however. More of them should be used in soil conservation farming. Most crop rotations do not have enough grass and legume crops. Many acres of eroding land now under cultivation would produce more if planted to grass. Most important, however, grasslands of the Nation are producing only a fraction of what they are capable of.

The Grass Crops

Grass crop, as used in this bulletin, is any grass or legume or mixture of grasses and legumes, whether seeded or growing naturally, raised mainly for seed, forage, erosion control, or soil improvement. It does not include legumes such as soybeans and peanuts

Figure 1.—Grass crops are one of the most effective tools available for soil conservation. Grass waterways and grass in strip-crop rotations on this Wisconsin farm both protect and improve the soil.

or such annual grasses as corn and sorghums grown as row crops, nor such grass crops as wheat, barley, and oats that are grown mainly for grain.

Most of the grass crops are soil builders. This is especially true of the perennials that are allowed to grow for several years. They protect the soil against erosion and usually improve its fertility and structure. This is in sharp contrast to the way most annual crops, especially the clean-tilled crops, affect land. They use up all the plant nutrients they can take from the soil and furnish little protection against erosion.

Using Grass Crops in Conservation Farming

Grass crops, when properly treated, are one of the most effective tools available for conserving and improving the soil (fig. 1). In fact there is no practical way to do conservation farming on most land without growing grass at least part of the time. Moreover, the profitable uses of these crops in conservation are many and varied.

Because you grow a lot of grass doesn't necessarily mean you are practicing conservation, however. Even with all your land in grass, you are not a conservation farmer unless you treat and use the grass properly. The grass crops are simply tools of conservation farming.

Altogether, about 45 million acres of present cropland in the United States is not suited for cultivation. Nearly all of this land would produce more if converted to good grassland or to woodland (fig. 2). And it would be protected from erosion. When more cropland is needed, some of the 75 million acres of present grassland suitable for cultivation can be plowed up.

Many farms need grass in small criti-

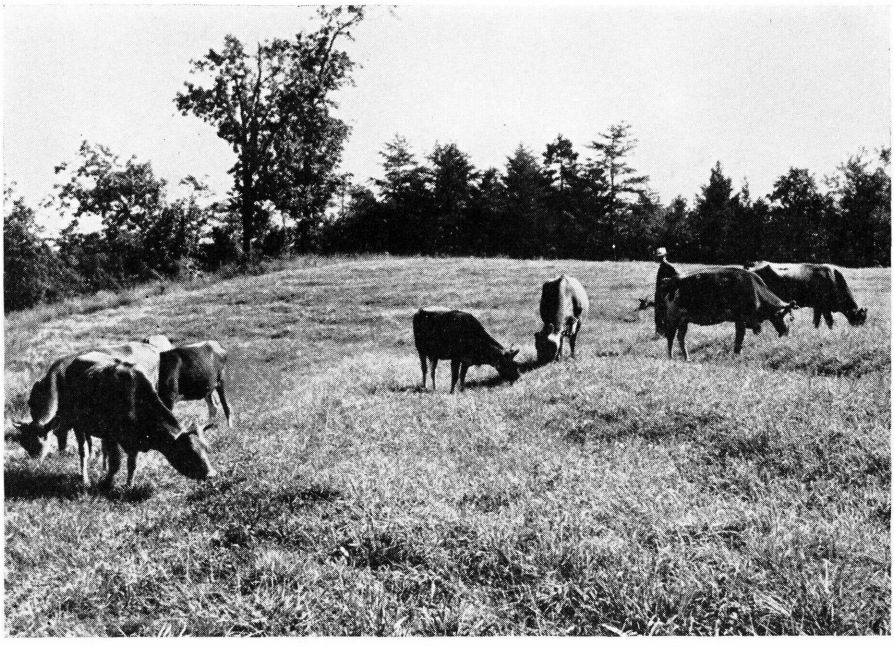

Figure 2.—This North Carolina contour-furrowed pasture was formerly cultivated. Steep, erodible slopes usually yield more income if planted to good grass crops than to cultivated crops. Grass also protects the slopes from erosion.

Figure 3.—**Little bluestem grass planted on this eroded hillside in Oklahoma has healed the gully and made an excellent pasture.**

cal areas that are eroding rapidly. Not more than one-fifth of the Nation's farms have enough grass waterways and sodded diversion or terrace channels. These areas would not only be protected against erosion if planted to grass, they might also help protect much larger areas. And they would produce crops of hay or silage.

More annual cover crops and green-manure crops would help protect the land against erosion and improve soil structure and fertility.

At least 90 percent of our present grassland is not producing nearly so much as it could. The grass cover on many pastures and ranges is not even adequate to control erosion.

Good conservation farming calls for meeting all these needs for grass crops, and it requires that the grass crops be good crops—that they be given care and proper treatment.

Grass Protects Soil and Improves It

A good grass crop protects and improves the soil in several ways: (1) Prevents soil erosion, (2) improves soil structure, (3) increases soil productivity, and (4) improves the biological life of the soil. Both the tops and roots of grass plants help do these things.

Since a great part of water erosion starts when raindrops blast particles of soil loose, a blanket of grass is very effective in checking erosion (fig. 3). The blades or leaves break the force of the falling raindrops. Large drops are then shattered into much smaller drops that trickle slowly to the ground. In addition, grass helps prevent raindrop splash from sealing the pores of the soil and thus permits water to soak into the ground more rapidly.

Grass plants, whether living or dead, also slow down runoff. Each blade, leaf, and stem acts as a tiny check dam. They also help catch and hold soil particles that the water may be carrying. And the slower runoff permits the soil to soak up more of the water.

The blades or leaves of a good grass crop also protect the land from the force of high winds, and thus help prevent wind erosion.

Grass tops add humus, or organic

matter, to the soil if you leave them on the ground or plow them in. The amount may be considerable where the grass crop is grown for several years.

The roots of grass plants are usually fine and numerous. Like the grass tops, they help protect the soil against both water and wind erosion. They improve soil structure and productivity by adding organic matter and by helping to separate soil particles in tight land. They also help create small openings that allow water to soak into the ground. If the grass crops are legumes, they may add nitrogen to the soil.

The Value of Grass in Protecting Soil

Measurements made at several experiment stations show how effectively grass protects soil against erosion and runoff. For example, the soil conservation experiment station at Guthrie, Okla., found that more than 10 times as much water ran off an 8-percent slope planted to cotton as off the same kind of land covered with bermudagrass. And nearly 500 times as much soil was washed from the cottonfield as from the bermudagrass field.

At Bethany, Mo., the soil conservation experiment station found that more than 4 times as much water ran off a sloping cornfield as off the same kind of land planted to alfalfa. And the soil loss was about 400 times as great from the cornfield as from the alfalfa field. Results have been similar at other experiment stations.

The Value of Grass in Improving Soil

Growing grass crops in long-term rotations nearly always increases the overall productivity of a field (fig. 4). For example, an experiment at Urbana, Ill., showed that where corn was grown continuously for 22 years, the yield was only 25.1 bushels an acre. On similar land where grass crops were grown half the time, the corn yields averaged 50 bushels an acre. In other words, yields from 11 crops of corn

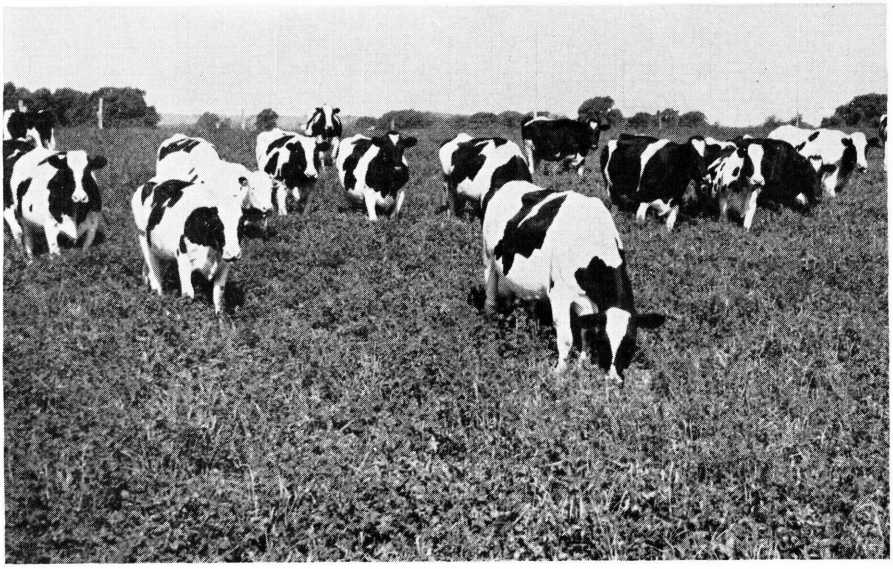

Figure 4.—Growing grass crops in long-term rotations nearly always increases the overall productivity of a field. On this Illinois field bromegrass and alfalfa will remain on the land 2 to 4 years. After that the field will again be planted to cultivated crops for a similar period.

from the rotated plot were almost equal to the yields from 22 crops from the plot where corn was grown each year. In addition, the soil on the rotated plot was more than twice as productive at the end of the period.

At Batesville, Ark., similar results were obtained in a 10-year test with cotton. A plot planted to grass half the time (5 of the years) actually produced more cotton than another plot planted to cotton all 10 years.

Under clean cultivation organic matter in the soil is exhausted rapidly. The cheapest and easiest way to replace it is to grow grass crops on the land part of the time (fig. 5).

Soil analyses show that the top 6 inches of soil on most virgin grasslands of the United States contains from 25 to 100 tons of organic matter per acre. It has, of course, accumulated over a long period. But experiments show that the grass roots alone may add as much as 1,000 to 2,000 pounds of organic matter per acre to the top 6 inches of soil each year. If you leave the tops of the grass plants on the ground or plow them under, you may add several tons of organic matter a year.

Increased Production and Profits From Grass Crops

Many American farmers believe that most land will yield a higher income from cultivated crops than from grass crops. As a matter of fact, much of the land that is now being farmed to row crops would yield a greater net income if it were seeded down to grass. It would produce a greater amount of digestible nutrients for livestock. It would produce more pounds of beef or gallons of milk per acre.

This applies not only to the millions of acres of eroded and submarginal land now in row crops, but also to much of the marginal land, especially to those fields that have been planted continuously to cash or grain crops for several years.

In a North Carolina experiment, an

Figure 5.—**This Michigan cornfield was seeded to rye for a winter cover crop. The rye will not only protect the land against erosion and furnish some good grazing, but also add organic matter to the soil when plowed under as green manure in the spring.**

improved pasture produced forage equal in feed value to 87 bushels of corn per acre on land capable of producing only 50 bushels of corn. In an experiment at State College, Pa., an improved pasture produced forage equal in feed value to 90 bushels of corn per acre on steep land that was unsuited to growing corn. At the Tifton, Ga., experiment station, an improved pasture produced 569 pounds of beef per acre in 1 year, plus more than a ton of high-quality hay.

Not only is the production per acre higher for many cultivated fields when turned into grasslands, but the cost of production is usually much lower. Labor, machinery, and seed costs are less. For example, in North Carolina experiments, it was found that the return per man-hour of labor was about $23 for good pasture but less than $4 for corn and less than $6 for wheat.

At the Dixon Springs, Ill., experi-

ment station a 60-acre pasture produced an average of 435 pounds of beef and mutton per acre. At 30 cents a pound for the beef and mutton, the gross return from this pasture was about $130 an acre in 1951. It cost about $50 an acre to establish the pasture, but the cost of maintenance was about a fourth as much after the pasture was established. And the production should be as great for several years.

Farmers throughout the country have been getting results similar to those of the experiment stations.

Paul C. Schroeder of the Antelope Valley Soil Conservation District in California reports that he got a net return of $112 per acre from his irrigated pasture in 1950 by grazing beef cattle on it. This was net profit after subtracting all costs, including the cost of the irrigation water.

Tony Wilmer of Huntsville, Ala., reported in 1951 that he pastured 30 head of cattle the year round on a field that produced only 3 wagonloads of corn in 1946—the last time he grew corn on it.

Ross Perner, Jr., in the Triangle Soil Conservation District of Arizona, produced 994 pounds of beef per acre from a 40-acre irrigated pasture in 1951. With beef selling at 30 cents a pound, his gross income from the pasture was almost $300 per acre.

R. B. Wenger of Harrison County, Miss., reported in 1951 that in 4 years he harvested 12,900 pounds of Bahia grass seed and 225 tons of hay from a 12-acre plot. He spent $1,634 for fertilizers for the plot, but the hay was worth $5,625, and he sold $11,490 worth of seed.

Bert Roy of Roosevelt County, N. Mex., took 480 acres out of cultivation and planted it to weeping lovegrass in 1949. For several years he grazed 85 head of cattle on the pasture the year round. He said that the grass was giving him a greater and more certain income than were the cultivated crops he used to grow.

George Schutte of Burlington, Colo., planted 150 acres of his terraced wheatland to crested wheatgrass in 1945. For the next several years this field furnished early spring grazing for his entire herd of cattle. He says that the grass gave him a better return than he ever made from the land when he was growing wheat on it. Mr. Schutte also had 10 acres of intermediate wheatgrass that he used mainly for hay. In 1951 he produced $900 worth of hay from this 10-acre field.

Bill Darbyshire of Calhoun County, Iowa, reported that in 1950 he had a 28-acre pasture that produced more than 400 pounds of beef per acre. He estimated that his gross return from this pasture was about $115 per acre, and it would have been only about $80 per acre if he had planted corn.

Lester Henshow of Grove Center, Ky., had 50 acres of improved grassland that he said, in 1952, was returning him a net gain of $100 per acre.

S. D. Wilhite, a cooperator with the Putnam County Soil Conservation District in Tennessee, seeded a 33-acre field to tall fescue and Ladino clover in the fall of 1951. He began grazing the field with beef cattle the following spring. During the first 9 months of grazing, the pasture produced about 250 pounds of beef per acre.

B. W. Householder of the Coastal Soil Conservation District in Georgia reported in 1952 that he had been averaging more than 400 pounds of beef per acre each year from an improved pasture of tall fescue, coastal bermuda, and Ladino clover.

Numerous other farmers are getting much greater production and profits from improved grasslands than they could get from growing cultivated crops on the same land. You can read stories about them in almost any issue of every popular farm magazine published.

Clarence Roecker near Clear Lake, S. Dak., summed up the average conservation farmer's experience when he stated in 1953: "Although we have more grassland and fewer cultivated acres than before, the farm's produc-

tion has risen by about 25 percent. We get more grain from fewer cultivated acres than before, and have the production from the grass in addition."

Grass for Flood Prevention

Grass is also an important tool in flood prevention. Tests show that the amount of runoff from good grassland is much less than from cultivated fields or bare land.

An experiment at Statesville, N. C., showed that nearly 30 percent of all the rainfall ran off a bare fallowed field; about 11 percent off a field planted to cotton; and less than 2 percent off similar land that had a good grass cover.

Furthermore, the amount of mud contained in the runoff from grassland is almost negligible, while huge amounts are in the floodwaters that come from bare or clean-tilled fields. The mud in the water increases the total amount of flow and causes greater damage from flood sediment.

The Soil Conservation Service and farmers cooperating with soil conservation districts are using grass crops extensively in watershed treatment for flood prevention. For example, in the Upper Washita Soil Conservation District of western Oklahoma, more than 10,000 acres of eroding cropland, bare range, and idle land were planted to native grasses in 1951 as part of the flood-prevention program.

More than 2½ million kudzu crowns were planted in 1951 in the Little Tallahatchie River watershed of Mississippi, as part of a like flood-prevention program.

Good Grass Crops vs. Poor Grass Crops

Nearly 60 percent of all the land in the United States, over a billion acres, is used for grazing or hay. This includes about 660 million acres of range and permanent open pasture, about 345 million acres of woodland and forest pasture, 75 million acres of hay

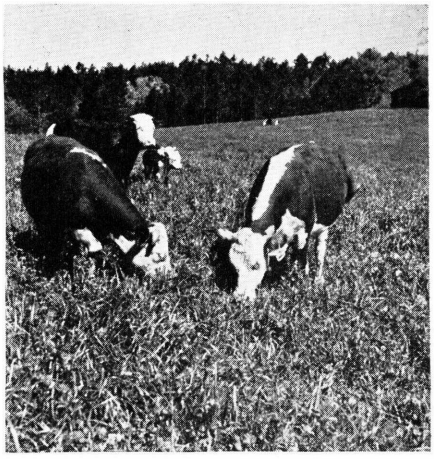

Figure 6.—**This improved Georgia pasture produces 4 to 5 times as much forage as unimproved pastures of the same area. The land was fertilized with manure and 900 pounds of commercial fertilizer per acre, then planted to a mixture of Kentucky 31 fescue and Ladino clover.**

land, and nearly 50 million acres of cropland used for pasture during a part of each year. Only a small part of this land is now producing excellent hay and pasture crops.

Where moisture is not a limiting factor, most grassland would produce from 2 to 4 times as much forage as it is now producing if improved according to knowledge we now have (fig. 6). Also, it usually would produce a forage of higher quality. The plants would be more succulent and more palatable. The protein content of both pasture and hay would usually be higher.

Furthermore, a thick stand of grass prevents erosion of any consequence; but a scant stand, while more effective than clean cultivation, may permit severe erosion.

At Zanesville, Ohio, an experiment showed three times as much runoff and twice as much soil loss from an unimproved pasture as from a pasture that had been limed, fertilized, and planted to a good mixture of grasses and legumes.

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How Grass Plants Grow and Produce

Each grass or legume plant, like any other plant, is a small factory. We might compare it to an automobile factory that operates its own mines, rubber plantations, and transportation system.

The fine roots (root hairs) of the plant are comparable to the miners and plantation workers. These roots collect raw materials from the soil.

The large roots and stems serve mainly as a transportation system. They carry the raw materials to the leaves and the plant food manufactured in the leaves back to the fine roots.

The factory proper is in the blades or leaves. Here, the raw materials are converted into carbohydrates, proteins, and fats. The surface of the leaves might be compared to the floor space of a factory. The green matter in the leaves—the chlorophyll—acts as factory workers and machines. In addition to the raw material from the soil—such as nitrogen, phosphorus, potassium, calcium, and water—leaves get other raw materials, mainly carbon dioxide, from the air.

A grass plant, like an automobile factory, must use a lot of material to take care of its factory systems. It must replace all worn-out parts. It must expand its transportation system—grow larger and longer roots—to reach deeper into the soil and search out more and richer raw materials. It must grow many more root hairs to mine the raw materials. It must expand the floor space of the factory—increase the surface area of the leaves—so that still more food can be manufactured.

To do these things the plant itself must have first priority on the use of the carbohydrates and proteins it manufactures. Otherwise the plant would either die or become stunted.

But if a grass plant has plenty of raw material and is well managed, it will produce a large surplus above that needed to maintain itself. You can then use this surplus for grazing animals, or you can harvest it as hay or silage.

As with factories, some plants are more efficient than others or are better adapted to certain uses. You wouldn't try to manufacture late-model automobiles in an 1890 wagon factory. Neither should you use a poor or unadapted species of grasses and legumes if you want good pasture or meadow. There are efficient species and varieties of grass plants for every soil and climate. And there are efficient species for every use, whether it be pasture, hay, silage, erosion control, or wildlife food and cover.

How To Grow Better Grass Crops

If you think of grass plants as self-sufficient factories, you can readily see why careful selection and treatment of the plants are necessary if you are to have good pastures, hay fields, and cover crops. A grass crop will grow on most land even though given poor treatment. Often it grows without being planted. But seldom will you have the best grass crop unless you give it as good care as you give your cultivated crops.

Here are some management suggestions:

1. Make definite plans to grow better grass crops that fit your farming or ranching system and your land.
2. Choose good varieties that are adapted to your land and climate and your needs.
3. Furnish the plants with plenty of plant nutrients.
4. Conserve and use available water so that the plants get the right amounts of water at the right times.
5. Eliminate weeds, brush, rodents, insects, and other pests that compete with the grass plants for food and water or that destroy the plants.
6. Graze or mow the grass crops so

that enough leaf surface is left during the growing season to manufacture the food necessary for rapid growth.

Planning Improvement of Grass Crops

Good grass crops don't just happen; you have to plan for them. Increasing their yield may be fairly simple or it may be very complicated.

Better grazing management is the main thing needed on some pastures. Fertilizing or liming is all that is needed on others. Some pastures need drainage, irrigation, brush control, or removal of stones and stumps. Many pastures, hay fields, and ranges need to be replanted to improved species; others will reseed themselves if properly managed. A combination of these measures is needed for many grass fields of the country.

Your first step in planning for better grass crops is to get an inventory of the capability of the land on your farm or ranch. No two fields are exactly alike. Therefore, you may need a different treatment or different kind of grass for each pasture, hay field, or range to make it produce its best crop.

If you are cooperating with a soil conservation district you can get a land-capability map or a range survey of your farm or ranch on which to base your plan for grass crop improvement.

Then you should take into account the kind and amount of grass you already have and how much more grass you need. Consider the kind and amounts of livestock you wish to keep and the other crops you wish to grow. Decide how you wish to use each grass field—for hay, pasture, silage, or seed production. Take into account also how much grass you will need in the rotations on your cultivated land and which fields would do best in permanent pasture or hay.

In other words, your plans for grass improvement should fit into a plan for soil conservation and improvement on your entire farm or ranch.

Choosing a Grass Crop

In choosing the kind of grass plants to grow, you should consider many things. You must, of course, take into account the kind of land you have and the climate. Some grasses do well on wet soils; others do well on dry soils. Some grow best on clay; others prefer sandy soils. A few will grow on almost any type of soil if you give them enough water and plant nutrients.

You should also consider how you expect to use your grass crops. Some grasses are best suited for making hay or silage, others for grazing. Some are most useful as annual cover crops. Others are excellent for permanent erosion control. Some are suited for short-term rotations, others for long-term. A few grasses do well for almost any use.

Since there are so many good grass varieties, it will probably pay you to get expert advice before you make your choice. Your local soil conservationist, county agent, or State experiment station can help you.

Establishing a Stand

Up to the last 20 to 30 years farmers and ranchers of the United States seldom planted grasses for permanent pasture. They just let nature plant the kind of grass she chose to grow; then they harvested it by grazing. Likewise, many of the permanent hay fields were not planted; and very little grass was planted for erosion control, wildlife, or annual cover crops. About the only grass crops planted were the rotation meadows and pastures on cultivated fields. As a result, many pastures, ranges, and hay fields had a thin stand of inferior grasses mixed with weeds.

During the last 20 years, however, the attitude of many conservation farmers and ranchers has changed. They now think it is just as important to plant the right kind of grass crops as it is to plant improved varieties of

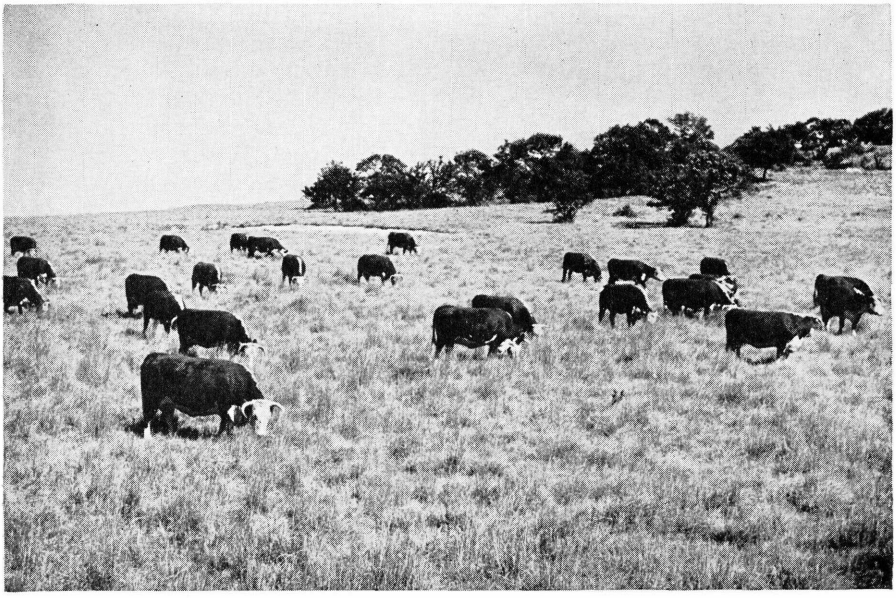

Figure 7.—**This Texas range was in poor condition before the rancher seeded 2,000 acres with a mixture of little bluestem and grama grasses and started a better system of grazing management. It now produces 3 to 4 times as much beef as it did before.**

cultivated crops (fig. 7). They have found that about the only way to get a good stand of the best grass is to plant it.

They not only plant grass on new pastures and hay fields, they also plow up many of their old meadows and pastures, especially where the stand is thin or weeds are numerous, and plant a new crop of grass on them.

But establishing a good stand of grass often requires more careful seedbed preparation and planting than most cultivated crops. And seeding failures are more common for grass than for cultivated crops.

SEEDBED PREPARATION

You should prepare a good firm seedbed for most grass crops. The fine seeds will not germinate and come up uniformly if planted in loose or cloddy soils. And you should kill the weeds before planting the grass.

If your land is subject to wind erosion, you should have a mulch of straw, stalks, or stubble on the ground when the grass is planted, and you may need a mulch on sloping land subject to severe water erosion. A mulch may also keep the ground from drying out or crusting and thus help you get a more uniform stand of grass even on level land.

One way to get a mulch is to plant a cover crop the year before you plant the grass crop and leave the stalks or stubble on the field. You can kill the weeds by subsurface tillage or disking that leaves the mulch on the ground surface. Where moisture is available, you can plant a mulch crop with the grass. Or you may get a mulch cover by spreading straw or old hay over the ground after the grass is planted.

TIME OF PLANTING

Planting at the proper time is also important for most grass crops. Fall plantings are usually best in warmer regions. The grasses have time to make good growth before spring and

summer weeds come up. And they are able to choke out most of these weeds that might compete with them for plant food and soil moisture. Where fall planting is impractical, however, plant in the spring.

METHOD OF PLANTING

Uniform planting at the right depth is essential if you expect to get an even stand of grass. Broadcasting, followed by harrowing or disking, seldom gives a satisfactory stand. A drill is best for planting most grass crops. A regular grain drill will plant many of the large heavy seeds satisfactorily. Some of the fine seeds and the trashy ones need a special grass-seed drill.

Where mixtures of coarse and fine or heavy and light seeds are planted, be sure the seeds remain well mixed during planting. Otherwise, the heavy or fine seeds are likely to settle to the bottom and be planted first. For some mixtures, you may need an agitator in the seed box or a dilutent to keep the seeds well mixed.

It will nearly always pay you to fertilize your grass crops at planting time. A good way is to use an attachment that places a band of fertilizer in the drill rows below the grass seeds (fig. 8). In this way the young grass plants use most of the fertilizer directly beneath them and thus get a better start than the weeds which they have to compete with. On the other hand, if you broadcast fertilizer over the entire field before planting the grass, weeds that come up between the drilled rows of grass may use most of it.

On some sandhill areas, a good way to plant grass is to cover the ground with hay mowed from a field when the seeds are mature. Then, run a disk over the hay mulch after it is in place.

On some western ranges and sandhill areas, broadcasting is used because it is less expensive and takes less time. You can broadcast by airplane, but such broadcasting seldom produces a good stand of grass. You may get a partial stand if you disk or harrow the ground just before broadcasting.

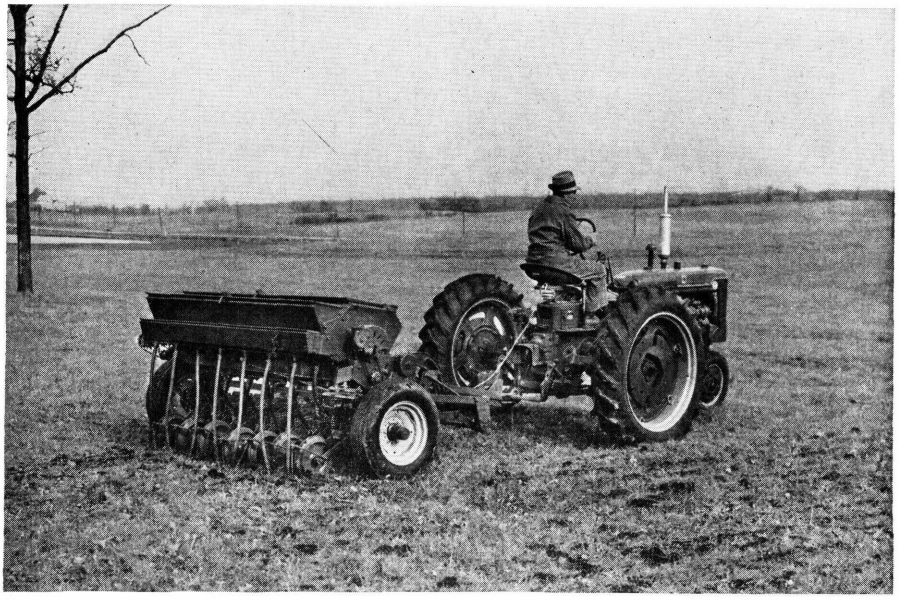

Figure 8.—This combination fertilizer and grass-seed drill places a band of fertilizer in the drill row below the grass seed. In this way the grass seedlings use most of the fertilizer.

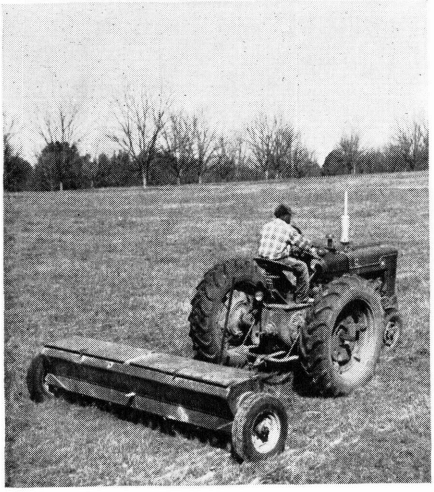

Figure 9.—**Plenty of fertilizer applied to this excellent pasture in the fall will help the grass crop build up its root system and be ready for rapid spring growth.**

NATURAL REVEGETATION

Where you have a thin stand of desirable grasses, it may be thickened by not grazing it while the plants are producing seed. This is commonly called natural revegetation. You will get more uniform revegetation if you harrow or disk the land after the seed crop matures.

Furnishing Plant Nutrients

On fertile, rich soils you may not need to furnish extra plant nutrients to grow a good grass crop. But it will usually pay to fertilize, even on rich soil, if there is enough moisture to fully use the fertilizer (fig. 9). It will always pay to fertilize grass crops growing on poor soils, provided there is adequate moisture.

Fertilizers help furnish the raw materials from which the grass plants manufacture finished plant food. The more raw materials the plant has the faster it will grow if plenty of water is available.

Barnyard manure makes a good fertilizer for grass crops. So do the droppings from grazing livestock if the droppings are scattered regularly. But most grass crops, in humid or irrigated areas, need more plant nutrients than they can get from livestock droppings. You should apply liberal quantities of commercial fertilizers if you wish to get the most from your crop.

There is no standard formula for the best fertilizer for the different grass crops. A great deal depends on what is already in the soil. If you have your soil tested, you can tell better which elements are lacking. Then you can apply fertilizers that fit the needs of the plants and the soil.

Phosphorous, potash, or any other essential element that is lacking should be supplied in fertilizer, but especially nitrogen. The amount of nitrogen furnished a grass plant largely determines the amount of growth it will make.

Legumes, if properly inoculated, take a part of their nitrogen from the air in the soil. Hence they may not need nitrogen fertilizer. Where legumes and grasses are planted in mixtures, the legumes will supply some of the nitrogen needed by the grasses. But it may pay to apply some nitrogen fertilizer to these mixtures if the soil has been growing row crops or is low in fertility.

Many dairy farmers of the Pacific Northwest apply 300 pounds of ammonium nitrate or 600 pounds of nitrate of soda per acre each year to their irrigated pastures. The fertilizer is usually applied in three equal parts. They also apply phosphate fertilizer, but usually only once a year, in the fall.

Conservation and Use of Available Water

Water is fully as important as plant nutrients in regulating the growth rate of grass. Where the water supply is small, only the slow-growing short grasses can thrive. The fast-growing tall grasses and legumes must have

plenty of water, especially during the season of rapid growth. But plants can have too much water.

Where the land is too wet, you should drain it. Where it is too dry, irrigate if water is available. If irrigation water is not available, conserve water by every practical means and grow grasses that are adapted to the available water supply.

DRAINAGE

A few of the good grass plants grow well on waterlogged soil. But proper drainage is essential for high yields from most of the better grasses (fig. 10). A good drainage system usually pays off for grass crops as well as it does for cultivated crops.

Surface ditch drainage is most common for grasslands. Properly made ditches seldom interfere with grazing or mowing. Ditch drainage is usually cheaper than tile drainage. But if your grass crops are used in long-term rotations with cultivated crops, it may pay you to use tile drainage in addition to surface drainage.

Figure 10.—**Only marsh grasses grew on this 40-acre field until the drainage system was installed. Seeded to a mixture of white Dutch clover, bermudagrass, Dallis grass, and lespedeza, it now provides excellent grazing for 30 head of cattle.**

IRRIGATION

Irrigation usually pays off as well for grass crops as for cultivated crops. Some phenomenal yields have been obtained from irrigated pastures and meadows in the dry Western States. But irrigation benefits are not limited to dry climates. During summer drought periods irrigation has paid big dividends on many grasslands in humid areas even where the rainfall is greater than 40 inches a year.

Sprinkler irrigation is commonly used on grasslands (fig. 11). It gives a uniform application of water to all plants, and none of the land is taken out of production for ditches or embankments. The initial cost for a sprinkler system may be greater than for other methods of irrigation, but the advantages usually outweigh the added cost for most types of grassland.

Border irrigation and corrugation irrigation are also used on some grasslands. These methods are usually best on level land or on land with uniform slopes that permit even distribution of the irrigation water.

WATER CONSERVATION IN DRY CLIMATES

Runoff should be prevented and the rainfall conserved scrupulously in dry areas where irrigation water is not available. A thick stand of grass is the most effective means of checking runoff. The grass leaves help slow down the runoff, and the roots help keep soil pores open so that water can soak into the soil. On steep slopes or in regions where torrential downpours are common, you may need other conservation measures to help check runoff and conserve water.

Contour furrows are effective in checking runoff on many western ranges. So is pitting on many shortgrass ranges. And water spreading

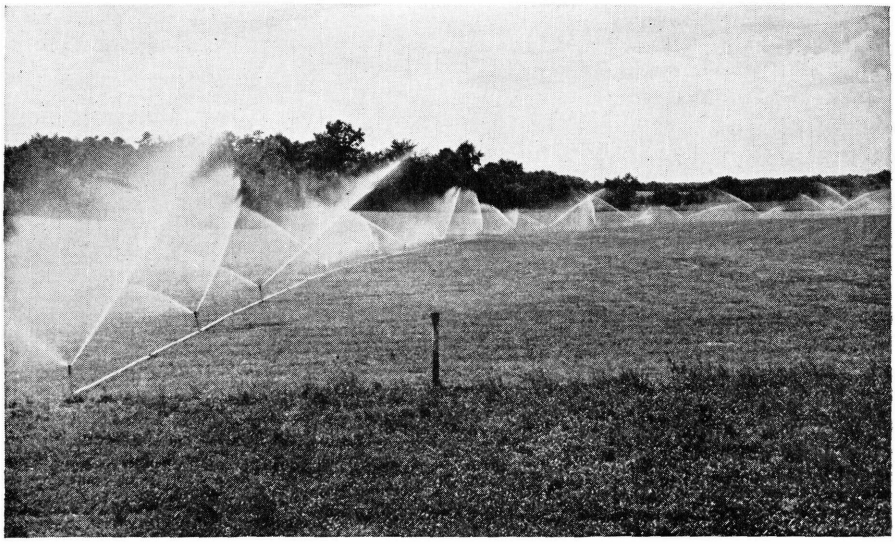

Figure 11.—A sprinkler system is used to irrigate this Connecticut pasture during summer droughts.

has proved practical where water can be diverted from a gully, highway, or steep hillside and spread over a more level area. You usually need expert technical advice in planning and laying out extensive water-spreading or pitting systems.

Control of Weeds, Brush, and Other Pests

You can't grow good grass crops if they have to compete with weeds, brush, or trees for the moisture and plant nutrients in the soil. Nor can you get the best yields if rodents, insects, or other pests consume much of the forage or kill the plants. These pests must be controlled if you want a good pasture, range, or hay field.

As previously explained, weeds should be destroyed before the grass crops are planted. Even so, some weed seeds are likely to grow afterward, and weeds are also likely to appear in established grass stands. The best method of control is to keep such a dense stand of grass that the young weeds are choked out for lack of sunlight, moisture, or plant nutrients.

Mowing during the growing season helps greatly in controlling the weeds that do grow. Where pastures and hay fields are so weedy that mowing is not practical, you should plow and replant them.

Spraying may be used on some grass crops. Several available sprays kill broad-leaved plants without damaging grasses. They cannot be used, however, if the crop is a mixture of grasses and legumes, because the sprays also kill the legumes. Nor should such sprays be used on grasses that are to be grazed soon after the spraying because some of these sprays are poisonous to livestock. In general, spraying for weed control is used mostly on grass fields that are to be harvested for seed.

Small or young brush can be largely controlled by mowing or by spraying with a broad-leaf weedkiller. On some established pastures, however, the brush may be so large that mowing is not practical. This is especially true on some western ranges where mesquite or other scrub trees have become thick. These may be killed by applying chemicals to the roots, by spraying, or by

uprooting them with a bulldozer (fig. 12). Either method is fairly expensive. But you must keep the brush and scrub trees under control if you want good range or pasture. If you have a large amount of such brush, it will probably pay you to get expert technical advice before starting eradication.

Prairie dogs and other rodents eat large amounts of forage and completely kill the grass in many spots. They should be killed by poisoning or other means. Serious insect pests can be controlled in much the same way for grasslands as for cultivated crops, except that you must be careful in applying poison sprays to grazing land.

Grazing and Mowing Grass Crops

Proper grazing or mowing is essential if you are to get the highest yields from most grass crops. Each pasture, range, or meadow should be grazed or mowed so that enough leaf growth is left to manufacture the food necessary for rapid growth of both the root system and the leaves.

Studies at the Soil Conservation Service observational nursery at Beltsville, Md., show that if you remove too much of the grass' top growth by grazing or mowing, root growth will stop until the tops recover. A single clipping of 90 percent of the foliage caused root growth to stop for 17 days. And where 70 percent of the foliage was clipped off and then clipped back to the same level every 2 or 3 days, root growth stopped. But clipping off 40 percent or less of the foliage did not stop root growth.

If you let livestock graze top growth

Figure 12.—An Arkansas farmer is clearing brush with a special brush rake attached to a bulldozer. After the brush is removed, he expects to plant a mixture of grasses and legumes.

too heavily, it not only lowers production but also weakens the plants. Mowing too closely or too frequently has the same effect. If the leaf surface is kept down throughout the growing season, the root systems will not be repaired and expanded. Plants may even be killed by overgrazing if drought or other unfavorable conditions exist.

On the other hand, if you do not graze or mow the plants they will use much of the food they manufacture to produce seed. Moderate grazing or mowing prevents them from using food for seed production and thus they use it for more leaf production. Hence, you will usually get the highest yields and have the healthiest plants where grazing or mowing is moderate.

PROPER STOCKING

There is no set rule you can use to determine the proper stocking rate for all your pastures. Some poor ranges may be overstocked when you graze 1 cow per 10 acres. Some improved pastures may be understocked when 1 cow per acre is grazed. Some grass crops make their rapid growth in the spring and will support two or three times as many cattle then as they will in the summer. Others make their main growth during the hot summer months. Pastures will support more cattle during wet years than during drought years.

The only safe way to tell how many cattle a pasture will safely support is to watch the grass. If it is being grazed too closely, remove some of the cattle. If you are cooperating with a soil conservation district, you may get a conservationist to help you estimate the best stocking rate for your different pastures. But even though you do this, you should still watch the grass and see that it is not seriously overgrazed.

UNIFORM GRAZING

Since each plant is an individual factory, try to see that all plants are grazed uniformly, insofar as practical.

On small pastures, the livestock graze the pasture uniformly, provided you have a uniform stand of grass. Try to keep the grass crop growing vigorously over the entire pasture, however. And scatter the droppings every few weeks. This helps to fertilize the pasture evenly and prevents the grass under the piles of droppings from being killed. It also prevents excess growth from lack of grazing around the piles.

You may find it more difficult to get uniform grazing on large pastures. Having several watering places helps in getting livestock to graze all parts. Placing salt licks away from watering places also helps. If you do pasture feeding, locate feeding places away from the water and salt.

Often it is advisable to divide ranges or pastures into two or more fields by fencing. Then you can restrict the grazing on the different fields according to how well the grass is growing.

DEFERRED GRAZING

Most grass plants produce more forage in the long run if you remove the grazing livestock during a part of each growing season. In the Western States this is usually called deferred grazing.

Deferred grazing is most common on pastures that have mainly one type or species of grass plant. On such pastures, you can usually increase the production by allowing a complete rest during a part of the growing season. Most grasses do best if they are not grazed until they make a good growth in the early spring. Others respond best if they are not grazed in summer. Some pastures may need the rest period during the fall, so that the plants recover from the spring and summer grazing before winter checks their growth.

If a stand of mixed pasture grasses is getting thin, it may be well to defer grazing while the most desirable plants are producing seed. The seed produced during the rest period helps revegetate some of the bare areas.

Figure 13.—This Louisiana farmer is mowing his pasture to help control weeds and to promote more uniform growth of the grass plants.

ROTATION GRAZING

Some stockmen find that the best way to keep all their pastures at highest production is by rotation grazing.

You can practice rotation grazing by several different systems. Some stockmen rotate between only 2 pastures. Others have 5 or more. Some graze all the pastures except 1; others graze only 1 pasture at a time. Some use a different pasture for each season of the year. Others rotate to a different pasture every 5 to 10 days. A few dairymen use a different one each day.

If you rotate the grazing according to the seasons, you will want cool-season grasses for spring, fall, and winter and warm-season grasses for summer. On the other hand, if you rotate frequently, you will want pastures that are fairly uniform in their production throughout the season. Frequent rotation is most commonly practiced on irrigated pastures or on improved pastures in areas with high rainfall.

For an ideal rotation grazing system divide the grazing land into 3 to 5 pastures of similar carrying capacity. Turn enough livestock into one pasture to eat most of the usable forage in 5 to 10 days. Then, move them to another pasture for a similar period, and so on. This lets each pasture get 3 to 4 weeks' growth between grazing periods.

If you have irrigated pastures, apply the water immediately after you remove the livestock and again about 2 or 3 days before you turn the livestock back in. Regulate length of grazing and rest periods for each pasture according to the growth of grass on it.

MOWING PASTURES

A mower is one of the grassland farmer's most important tools. Besides being the main harvesting implement for hay and silage crops, it is also useful in managing pastures (fig. 13). Mowing helps to control weeds and brush. It also helps to get more uniform grazing of the grass crops.

Even with excellent management,

grass grows faster, at times, than the livestock graze it. Hence, some of the grass plants become so rank that the stock refuse to graze them. Under such conditions, use a mower to clip the taller growing grasses. Often the livestock eat tall stemmy grass as wilted hay that they wouldn't touch while it is growing.

If you are practicing rotation grazing, the best time to mow a pasture is a day or two before the livestock are moved to another pasture. This gives the livestock a chance to eat most of the wilted cuttings and starts all grass off more evenly for the next growing period.

How Some Farmers Are Improving Grasslands

Let's look at what some of the better grassland farmers are doing toward improving their pastures and meadows through planting of better species and varieties, fertilizing, weed control, brush control, drainage, irrigation, and better grazing management.

Tom Folsom, near Monticello, Fla., had a 16-acre pasture that he planted to Pensacola Bahia grass in the spring of 1948. He top-seeded it to reseeding crimson clover in the fall of that year. For the next 4 years he fertilized and applied lime as needed. He kept down most of the weeds by mowing. During the spring and early summer of 1952 he grazed 33 head of cattle on the 16 acres, but the grazing cattle were not keeping up with the grass growth and seed stalks were beginning to develop. On July 16 he decided to harvest a seed crop from part of the pasture. For 13 days he kept the 33 head of cattle on 4 acres, and let a seed crop mature on the other 12. He harvested 2,700 pounds of seed and still had an excellent pasture for the rest of the grazing season.

The Pierson and Ovenall ranch in Skagit County, Wash., has 300 acres of improved grassland that was developed from former scrub forest and brushland. The improvement measures consisted mainly of clearing, seeding to a good mixture of grasses and legumes, fertilizing, and rotating the grazing. In 1951 the 300 acres furnished excellent grazing for 300 head of cattle from early spring to fall and, in addition, made 100 tons of hay and 150 tons of silage.

In Tillamook County, Oreg., many dairy farmers have found it pays to use sprinkler irrigation even with 90 inches of annual rainfall. Most of the rain falls during the winter and early spring. The summers and early falls are dry. These farmers construct drainage ditches on their level land to handle the excess rain, and install sprinkler irrigation to furnish water during the dry months. This way they have good pastures 8 to 10 months each year.

T. J. Luttrell of Brighton, Colo., from 1950 to 1952 grazed 200 yearling steers 6 or 7 months each year on a 40-acre irrigated pasture he fertilized with liquid anhydrous ammonia and phosphoric acid added to the irrigation water. Brome, orchardgrass, tall fescue, sweetclover, and alfalfa are the main grasses and legumes planted in Luttrell's pasture.

Louie Visintainer of Craig, Colo., proved that a range can be improved while sheep are grazing it. He had a 33,000-acre ranch that supported about 6,500 ewes and as many lambs. Controlled grazing by fencing, reseeding many areas with wheatgrass and other introduced grasses, and water spreading were his principal improvement measures. He seeded more than 2,000 acres and built about 130 ponds, 2½ miles of water diversions and spreaders, and 30 miles of fences.

Bill and Roy Cater of Taos County, N. Mex., had a field of more than 320 acres of nonirrigated crested wheatgrass which they grazed at the rate of 1 head of cattle per acre for 6 months and, in addition, harvested 100 pounds of seed per acre, in 1948. They used this field for spring and fall grazing and their native range for summer and winter grazing.

Clyde Delbridge of Brunswick County, Va., had a field so severely eroded it was laying idle. In the fall of 1950 he applied 2 tons of lime and 1,200 pounds of 2–12–12 fertilizer per acre and seeded the field to Ladino clover and orchardgrass. The following summer he started grazing it. During the first year of grazing the pasture produced $200 worth of beef per acre. This more than paid for the lime, fertilizer, seed, and fencing that were used on the area, and he then had an excellent pasture instead of a worthless tract of idle land.

Art Twitchell of Mount Upton, N. Y., pastured 35 head of dairy cattle on 33 acres of improved pasture for several years. The pasture was a mixture of Ladino clover, orchardgrass, and birdsfoot trefoil and was limed and fertilized regularly.

Harold C. Crouch of Shattuck, Okla., seeded a 66-acre field of blown-out sandy cropland to sand lovegrass in 1947. Soil blowing was stopped, and the pasture produced twice as much forage as most native ranges of the area.

On the Rather-Carter ranch near Gonzales, Tex., a 138-acre pasture of King Ranch bluestem supported 37 head of cattle during the winter of 1950–51. After 4 weeks' rest, 80 head of cows with calves grazed the pasture during the next spring and summer.

George Mays of Hall County, Tex., grazed 84 head of cattle for 60 days on 35 acres of blue panicum during the summer of 1949. Many other farmers and ranchers of the rolling plains of western Texas are using blue panicum for summer grazing to supplement their native grass pastures.

G. W. Jones and sons of Huntsville, Ala., grazed a cow and calf per acre the year round on a pasture of tall fescue with no supplemental feeding.

The Mercier brothers of San Jose, Calif., had a 66-acre irrigated pasture that carried 120 head of milk cows 8 months each year and supported 60 head with grazing the other 4 months. The pasture was established in 1947. At that time, the land was leveled and a system of border irrigation installed. It was planted to a mixture of grasses and legumes and divided into four fields for rotation grazing. Manure from the dairy herd was the only fertilizer used.

The Peace River Soil Conservation District in Florida, which had only native grass pastures a few years ago, established a nursery in 1944 for seed multiplication of some selected grasses. By 1952 the district had more than 100,000 acres of high-producing introduced grasses on pastures which produced more than 20 million pounds of beef a year.

These are but a few examples of what conservation-minded farmers are doing in various parts of the country; but they illustrate what can be done to improve grasslands and increase farm income through the use of more and better grass crops.

Harvesting and Using Grass Crops

Grazing is usually the most economical way to harvest and use grass crops. But whether the grasses are grazed, put up as silage, or cured for hay, they furnish an economical source of livestock feed. In 1951, the New Jersey experiment station figured the cost of 100 pounds of digestible nutrients for dairy cows from good pasture at $1.57. In the same experiment, the cost of 100 pounds of digestible nutrients from grass and legume silage was $2.40; from mixed hay, $3; and from mixed grain, $5.60. Though the cost of digestible nutrients from hay was nearly twice as much as from pasture, it was still little more than half as much as from grain. In other words, the cheapest milk, beef, wool, or mutton you produce usually comes from good pastures, and the most expensive comes from the grain you feed.

Grazing for Profits

Most grazing animals consume more

nutrients from pasture than from silage or hay because they like the fresh grass better. This means that you do not need to feed so much grain to get high production if you have good pastures. Since the protein content of the pasture forage is usually higher, you do not need to feed so much protein supplement, which is usually high in price. These things plus the lower cost of harvesting usually make the feed from pasture considerably cheaper than other feeds. An experiment at Purdue University showed that it cost only one-fourth as much to produce milk from good pasture as from hay and grain.

Many farmers and stockmen fatten steers to good or choice grades on pasture alone. In the Southern States some steers are fattened to good market grades on winter pasture. Lambs may also be fattened on good pasture. Some stockmen successfully produce beef cattle, sheep, and goats without feeding any concentrates the year round. They use only grass silage and hay to supplement their pastures.

Dairy cattle may also be kept in high production on good pasture alone. In a New Jersey experiment good milk cows produced 82 percent as much milk from high-grade pasture as they produced from pasture plus all the concentrates they would eat. For the highest production, however, you should feed some concentrates to heavy milkers.

Good pasture also makes excellent feed for hogs and poultry. An experiment at the University of Wisconsin showed that feeding costs for hogs were reduced as much as 30 percent by letting the hogs graze a good legume pasture. Even when the hogs were fed all the grain they would eat, feed costs were reduced 15 percent when good pasture was provided. Good pasture can also reduce feed bills for most types of poultry, especially geese and turkeys.

Since pasture is the cheapest feed for most livestock, you should strive to keep your pastures good for as much of the year as possible. In some sections of the South you may be able to have year-round grazing. You will probably not find it practical, however, to depend on pasture alone for all the roughage for your livestock. Hence, you may find it best to put up hay or silage for part of your winter feed.

Silage, the Best Substitute for Pasture

Grass and legume silage is the best and cheapest substitute for good pastures on most farms and ranches. Furthermore, you can put up silage in almost any kind of weather. You don't need to wait for good haymaking weather to put up grass silage.

Recent discoveries in making grass silage have greatly simplified the job. Little or no preservatives are now used where a mixture of grasses and legumes are ensiled. The silage can be made in an upright silo, a pit silo, a trench, or a stack. The grass may be chopped or ensiled without chopping.

Probably, your cheapest way to put up grass and legume silage is to stack the unchopped plants. Some farmers are now preparing excellent silage in this way. Other farmers use a portable forage chopper to cut the grass and load it into a truck or wagon.

At the stacking ground, dump the grass in a pile as long and wide as needed to make the stack at least 8 to 10 feet high. Pack the stack by running a tractor or truck over it while building it. You will get some spoilage on the top and outside edges of the stack, but this will not be excessive if the grass is well packed.

Trench silos also are used extensively for grass and legume silage. Next to stacks, they are probably the cheapest of all types to build. But more and more farmers are now using their upright or pit silos for grasses and legumes. They find that good grass and legume silage has almost as much value as corn or grain sorghum silage.

Better Hay for Feed and Market

Haymaking is often the most practical way to use a grass crop. Good-quality hay makes excellent feed for

most animals on the farm. It will tide your livestock through the winter when you have no pasturage. And once properly cured and stored, hay will keep for months or years without great deterioration. Hay also makes a good cash crop that may be harvested and shipped to distant markets.

Cut grass rapidly loses its green color, its palatability, and some of its nutrients if it is leached by rain or left exposed to sunshine for a long time. It may spoil until it is hardly worth feeding. Modern harvesting and drying equipment has taken many of the risks out of haymaking. Yet, much of the hay now harvested on American farms spoils because of lack of equipment for proper curing during bad weather. A still larger amount is leached until it is greatly inferior to good hay.

Grass Seed as a Cash Crop

Because of the grassland boom, more and more farmers and ranchers are producing grass and legume seed as cash crops. From 1935 to 1950 the supply of seed for many of the desirable grass crops was not nearly equal to the demand. Hence, some seed producers made extremely high profits by growing grass seed for market.

Since 1950 the supply of most grass and legume seeds has met the demand. Only those who produced high-quality seed of a scarce variety have made great profits. But the market for certified seed of the best varieties is good, and is likely to remain so.

Production of grass and legume seeds for market is a highly specialized business (fig. 14). You must produce high-quality seeds that are eligible for certification to be sure you can sell them. To do this, you face many hazards.

You must keep the grass seed free from weed or other varieties of grass seed. Your seed must have a high germination rate; this depends partly on the weather during harvesting. And the seed must be kept fairly free from moisture and from insect and disease damage until ready for market. Even then you cannot be sure of a good market. The supply for your particular seed may exceed the demand. Other factors, over which you have no control, may force you to sell at a loss.

If you plan to produce grass or legume seed as a cash crop, get the best technical advice available before plunging heavily into the business. Consult your local soil conservationist, county agent, or seed dealer and your State experiment station or seed certification association.

Grass Crops Create New Problems

There are disadvantages, of course, for a farmer who is just starting to grow more grass crops. It may mean more or different kinds of farm equipment. Usually it means that he must purchase some livestock. Additional fences may be needed. Barns and silos may have to be expanded. Often, new water facilities are needed for the livestock. Highly skilled farm labor is often required to handle the grass crops and the livestock they support. In addition, you should keep in mind the fact that grass crops are usually more difficult to plant and grow for the first season than are most cultivated crops.

Altogether, the change to more and better grass crops may add up to an almost complete overhauling of the farming system. Yet, the change is usually profitable in the long run. By wise use of grass and legume crops you can be assured of permanent production. The increase in yields will continue because the potential productivity of the soil will continue to increase.

If most farmers of the Nation should simultaneously start growing more and better grass crops and raising more livestock, they might create temporary surpluses of livestock and livestock products. This, in turn, would tend to depress the price of these products.

But the same problem usually arises when improved production methods are suddenly put into wide use for any product. The probability of overpro-

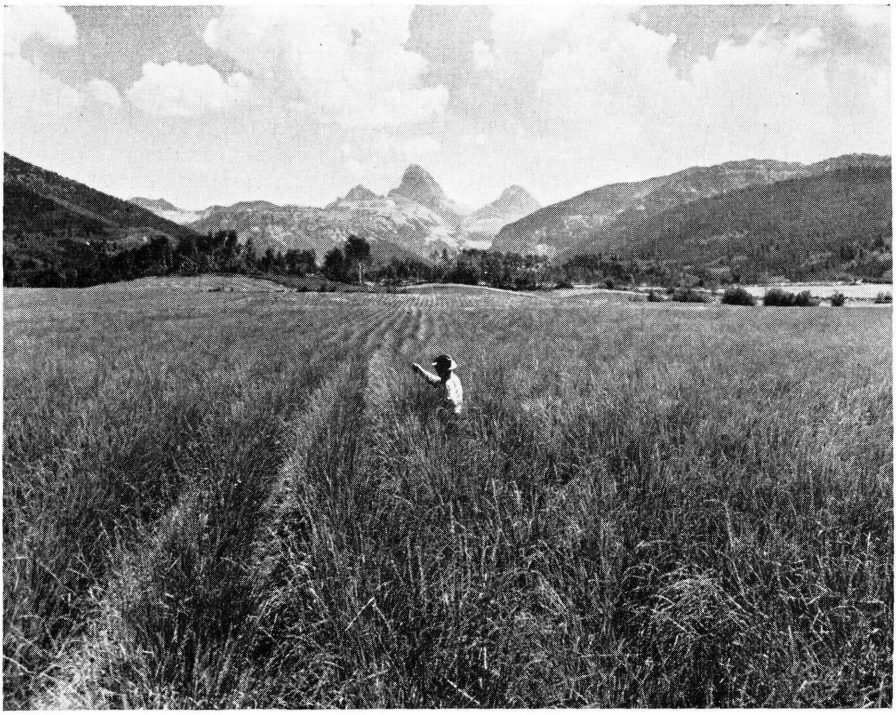

Figure 14.—**This Wyoming rancher is producing intermediate wheatgrass seed as a cash crop. The seed crop is almost ready for harvest.**

duction and depressed prices for livestock is no greater than for other farm crops.

A surplus production of livestock is not likely to become a permanent problem in the United States. The increase in population and in use of more livestock products in the diet should offset any increase in livestock production in future years. Furthermore, most other nations of the world are now confronted with shortages of livestock products.

A Permanent Agriculture for the Nation

The Nation as a whole, as well as individual farmers and ranchers, will reap long-range benefits from more and better grass crops. Good grass crops furnish the cheapest feed available for most types of livestock. The lower feed costs, resulting from better grass crops, mean lower costs of production. This, in turn, should result in lower food costs for the consumer.

The growing of more and better grass crops means better conservation of the Nation's basic soil and water resources. These crops increase the productivity of the land so that other crops that follow the grass produce more. In other words, grass helps to improve the productivity of the soil for future use.

Conservation farming with more and better grass crops assures us of permanent, high production from the farms and ranches of the Nation.

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